

**Advancing Personalized Learning
Through Iterative Application of Innovation Science**

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DRAFT for Discussion

“When asked what his rules were for the laboratory and its staff, Edison loved to respond, ‘Hell, there are no rules here—we’re trying to accomplish something.’ However,...it becomes clear that he did have powerful rules for innovation....Edison was the first person to create a system for innovation...Before Thomas Edison, innovation was viewed as the random product of a lone genius. Edison was, of course, an exceptional genius, but the greatest product of his genius was the establishment of a systematic approach to success that he believed anyone could emulate.” (Gelb, 2007, p. 6)

We believe the transformation to personalized learning (see more below) comes about through innovation, or more specifically a cycle of innovation that is a companion to continuous improvement. We posit that *innovation science* is the mechanism by which planned change occurs. Those interested in radical change often talk about a “culture of innovation,” which denotes an organizational attitude that favors experimentation or “thinking outside the box.” Some assume experimentation or creative thinking happens spontaneously, or only by a select magical individuals. We believe any and all members of an organization can be innovative, and that a culture of innovation arises from the behaviors of the individuals within it. When we change those behaviors we also change attitude, outlook, actions (i.e., culture).

Innovation science gives us the tools to orchestrate such a change. Innovation is rarely the result of a chance event; it is more often the result of planning, hypothesizing, repeated trials, even failing and starting again. We learn from our failures, and the more we fail the closer we are to success. This is the cycle of innovation. As noted by Manzi (2012):

...innovation appears to be built upon the kind of trial-and-error learning mediated by markets. It requires that we allow people to do stupid things that seem stupid to most informed observers—even though we know that most of these would-be innovators will in fact fail. This is premised on epistemic humility. We should not unduly restrain experimentation, because we are not sure we are right about very much. For such a system to avoid becoming completely undisciplined, however, we must not prop up failed experiments. (p. 224)

The problem in education is that mediating markets are weak and rare. The consequences of fruitless experimentation do not redound to the experimenter (researcher, school, or teacher, for example), but to the students. In education, a culture of innovation is more than an encouragement to tinker and a tolerance for missteps. A culture of innovation is not static but must be positioned within sound and deeply embedded processes for continuous improvement and, because caution is paramount, the safeguards inherent to science are in order. Again, an organization does not set out to create a *culture* of innovation; culture is the consequence of behaviors, of processes, procedures, and expectations that are embedded in scientific methods.

Culture of Innovation

A culture of innovation is an organizational attitude that favors experimentation and arises from processes, procedures, and expected behaviors.

The difference between invention and innovation, as explained in a blog by entrepreneur Tom Grasty (2012), is typical of how the terms are understood in our technological age: “In its purest sense, invention can be defined as the creation of a product or introduction of a process for the first time. Innovation, on the other hand, occurs if someone *improves on or makes a significant contribution to* an existing product, process or service” (para. 5). Grasty calls Steve Jobs the “poster boy of innovation” (para. 9), insisting that Apple did not invent products but found innovative applications of available technology. “Apple invented nothing. Its innovation was creating an easy-to-use ecosystem that unified music discovery, delivery and device. And, in the process, they revolutionized the music industry” (para. 10).

Thomas Edison invented the light bulb, and thousands of innovators have found new ways to use electric light in a multitude of contexts. All innovation, of course, does not rise from the application of an invention. Innovation may also be a better way of doing, finding a more productive practice or process. In fact, Edison, according to science-writer Steven Johnson (2014), was not the solitary genius who “invented” the light bulb, but one in a long chain of inventors and innovators, before and after Edison, who made minor, but sometimes very consequential, improvements to existing technology. Maybe there are no inventors, just innovators.

Walter Isaacson, the biographer of Steve Jobs and Albert Einstein, also debunks the image of the lone genius as inventor or innovator. The process of innovation is one of “collaborative creativity,” according to Isaacson, and “teamwork is important because we don’t often focus on how central that skill is to innovation” (p. 1). This sounds like sage advice for school leaders—unleash the power of collaborative creativity in a culture of innovation! But what, exactly, does that look like?

The process of innovation does not look like one more wave of pressure to do things differently just for the sake of change. As Mirabito and Layng (2013) remind us:

We need to (a) start talking specifically about the role of innovation in the organization and how it connects to very clear goals and priorities; (b) begin eliminating things—programs, practices, processes, and even innovations—that aren’t positively impacting

teaching and learning; (c) start creating a culture that promotes innovation in both language and action; and (d) begin developing a process to support, manage, and measure innovation. (p. 18)

Innovation and Improvement

Abraham Lincoln – “The dogmas of the quiet past are inadequate to the stormy present. The occasion is piled high with difficulty, and we must rise with the occasion. As our case is new, so we must think anew and act anew.” (Gelb, 2007, p. 24)

A culture of innovation emerges when the organization first establishes operational protocol for continuous improvement--always narrowing the gap between actual practice and best practice. At the same time, protocols are set to methodically seek better practices and better processes, and this is where innovation science comes in. Sustained innovation is the disciplined, systematic pursuit of better practices and better processes by everyone in the organization, looking for ways to more productively achieve the best results. In education, the practices we seek to improve upon are those that contribute to students’ learning. Innovation science provides the mechanisms to identify, measure, and adjust our practices and processes.

Ted Kolderie (2015) calls the simultaneous management of improvement and innovation processes “the split screen strategy” in his book of the same name. He advocates a “self-improving system, a successful system that changes gradually but in the fundamentals¹. That would be innovation-based systemic reform” (p. 13). Like Kolderie, Jal Mehta (2013) is skeptical of the ultimate potency of comprehensive, top-down, system change, motivated by the “allure of order” (p. 1) that has been the siren song of reformers for decades.

Mehta contends that attempts at comprehensive reform of the education system have been long on performance management and accountability but short on three other necessary components of any field: “(1) knowledge: developing the knowledge that will be used in the field; (2) human capital: attracting, selecting, training, and retaining the people who will work in the field; [and] (3) organizational processes at the site of delivery: developing effective processes that govern the work where it is going to be carried out” (p. 271). Taken together, Kolderie and Mehta favor decentralized, incremental reform, a focus on the fundamentals of improved practice, and school-based processes that foster collaborative pursuit of the most effective ways to achieve results for students. Of particular interest is the fact that innovation in this scheme is not a revolutionary departure from the norm, but a steady journey in getting the fundamentals right while selectively introducing new elements that prove to be more effective.

Redding, Twyman, and Murphy (2013) endorse the continuous processes of systematic improvement and innovation, heralding a science of innovation. They offer a narrative framework for stimulating and identifying innovations in learning. “The framework is organized around three domains: content,

¹ For an example of a self-improving “cybernetic” system of schooling, see Twyman (1998).

instruction, and personalization. Within each domain, principles of learning establish a psychological foundation for the standard practices. The standard practices provide a basis for comparison in assessing a new practice's effectiveness and determining its status as an innovation in learning" (pp. 8-9).

Figure 1: Cycle of Continuous Improvement

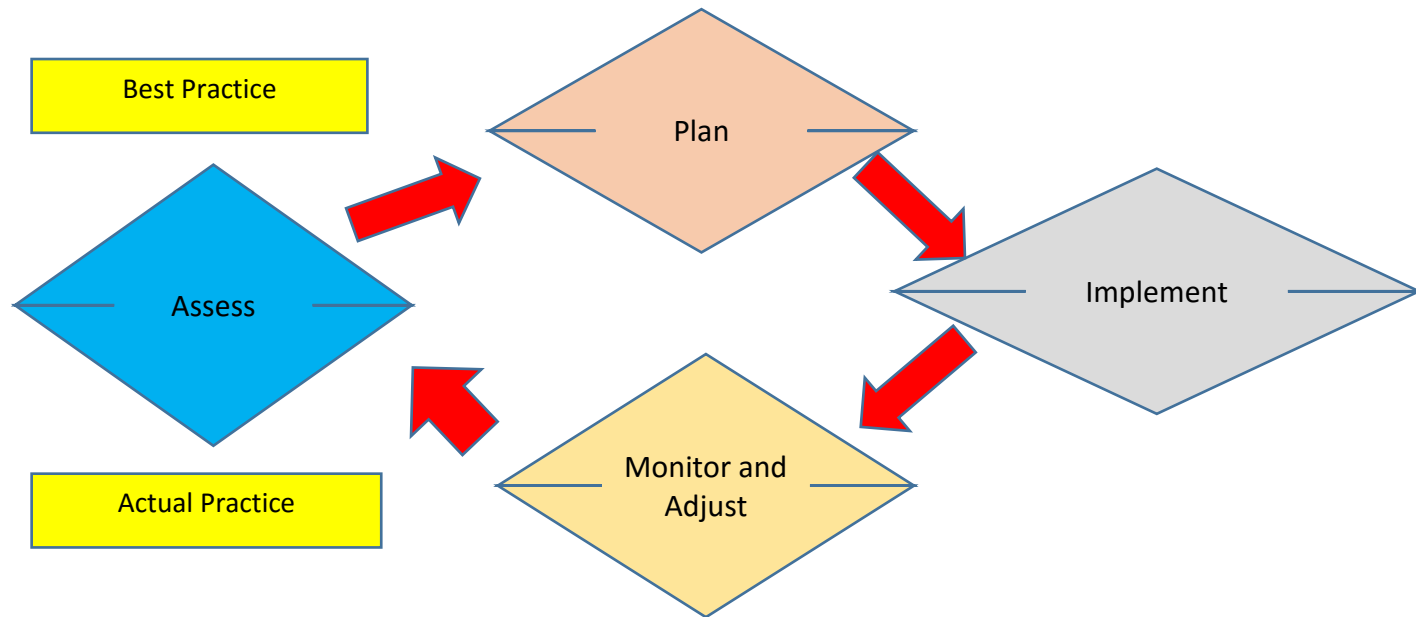
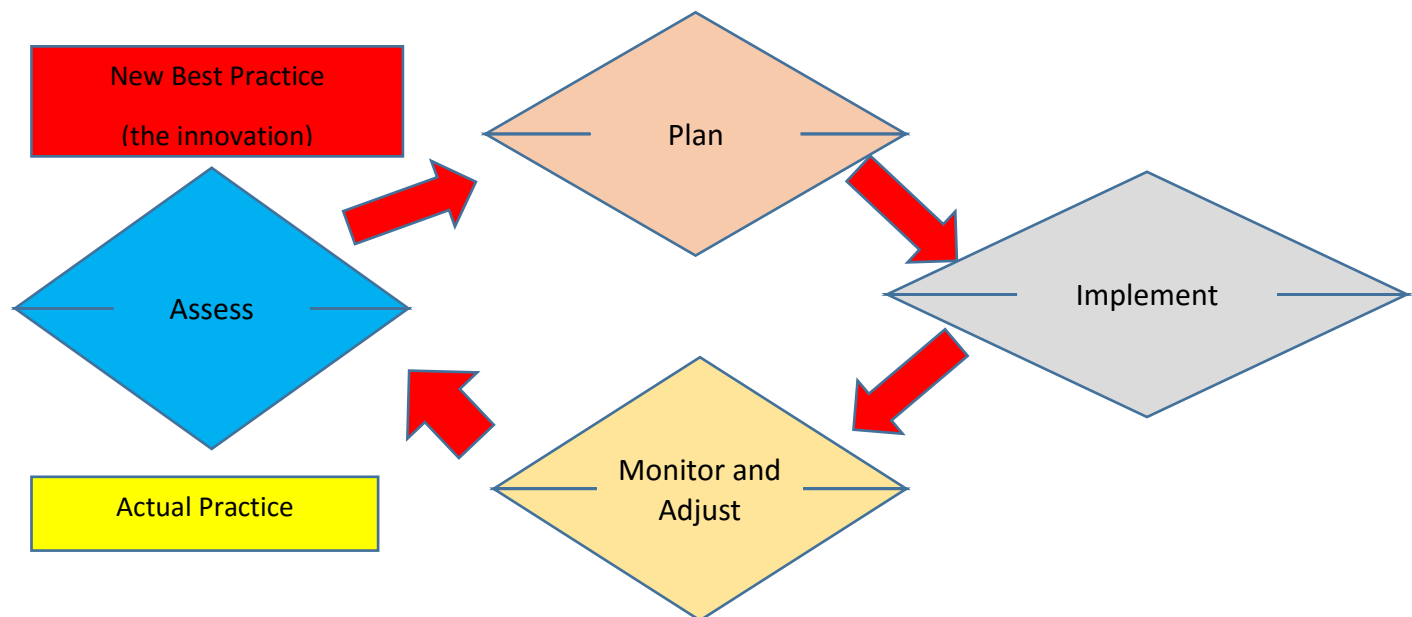


Figure 2: Innovation within the Cycle of Continuous Improvement



Innovation is more of a meticulous striving for better results using the tools of science than a thrashing about in hopes of a Eureka! moment. As Mirabito and Layng (2013) put it: “Innovation is planned change” (p. 15). The change is intentional, its implementation planned, and its results reasonably predictable.

Innovation and Technology

Layng and Twyman (2013) define technology as “the use and knowledge of tools, techniques, systems, or methods in order to solve a problem or serve some purpose” (p. 133). In education, innovation takes the form of advancement upon (or replacement of) techniques, systems, and methods for teaching and learning. The innovation may incorporate new tools (iPad, for example), which may or may not also be inventions.

Layng and Twyman describe two types of technology--tools (hardware and software) and processes (practices and the ways they are ordered and employed). They advocate the use of analytic data and scientific research to guide the development of tools and processes and to validate their effectiveness. Thus, learning science establishes a foundation of effective practice and process, and innovation science gives us traction in identifying and implementing practices and processes that are truly better.

Capacity in a Culture of Innovation

By setting up expectations and contingencies for the behavior of individuals in the organization, the organization fosters a culture of innovation. It does this by: (1) establishing operational protocol for continuous improvement (narrowing the gap between actual and best practices) and innovation (creating and validating better practices and processes); and (2) building the capacity of its personnel to manage change and enhance performance.

Organizational capacity resides in personnel and the manner in which they are equipped to perform the organization’s functions in order to add value for its clients. “In fact, there is a science to bringing the best from people, building their capacity for change, providing incentives for them to change, and opening avenues of opportunity that engage them in the work” (Redding, 2012, p. 3). Redding outlines the following four kinds of organizational capacity as embodied in its personnel and the way they work:

1. **Functional capacity**—Functional capacity is the collective skills and knowledge of personnel working in the organization. Functional capacity is increased by improving the skills and knowledge of current personnel, which means improving their practice. In some cases, functional capacity is built by adding or replacing personnel to bring new skill sets into the organization. In other cases, people are reassigned to add their personal skills and knowledge to areas where they are most needed.

2. **Motivational capacity**—The catalyst for a successful innovation is motivation (Christensen, Horn, & Johnson, 2008). Even when personnel possess the skills and

knowledge that an innovation requires, their best performance depends upon their motivation to adopt the new practice and persevere. The strength of motivation can be measured by a person's willingness to engage in an activity and to persist in it.

3. Social capacity—Social capacity (or social capital) is captured in the trust, communication, cooperation, coordination, and collaboration among personnel working to accomplish a shared mission. A highly functioning organization depends upon the requisite level and kind of human capital, but more is necessary than the accumulation of individual capacities. People must work together, inspired to achieve common goals. Social capacity is affected by the structures within which people work.

4. Technical capacity—Technical capacity includes tools (e.g., electronic devices), systems, processes, and protocols that guide and facilitate work. The organization's capacity to improve depends upon the quality and appropriateness of its technology and the proficiency of personnel in using it. (p. 15-17)

Intentionally enhancing the capacity of personnel contributes to a culture of innovation. Enhanced capacity supports the processes of improvement and innovation. With greater capacity, organizations can better apply innovation science, including implementing and evaluating innovations once they are identified and validated.

Where's the Science?

Innovation science offers an approach to understanding, analyzing, managing, and influencing innovation processes at both a direct and a strategic level. Innovation can proceed at several levels in education, with some form of scientific methodology at play at each level. The experimental bar of "gold standard research" is conducted in universities and education laboratories where expertise and budgets are sufficient to administer randomized controlled trials (RCTs). RCTs are more likely to validate an established practice than to foster innovation. Commercial enterprises are keen on innovation and bring many new products (and their associated practices) to the education market, some may carry with them independent validation and many do not. Within the public education system—state education agency, local education agencies, charter organizations, and individual schools—intentional protocols to encourage innovation are rare. Instead, educators rely upon universities, laboratories, and commercial enterprises to test and to confirm innovations.

Universities, education laboratories, and credible commercial enterprises rely upon scientific methods to identify and validate innovations. They either design and test variations from, or eliminate from consideration, ideas that fail to prove out. It is ideal when the education system, for the most part, adopts the practices proved effective by the research entities. Continuous improvement processes hold current practice up to the standard of effective practice validated by research and strive to close the gap between the two. When the education system does things systematically or empirically (instead of willy-nilly, based on preferences and opinions) most often it is to close the gap between current and best practice. Closing that gap, while important, is not innovation. Innovation requires systematic testing and analysis of practice (and process) beyond best practice, finding practices that are better (more effective

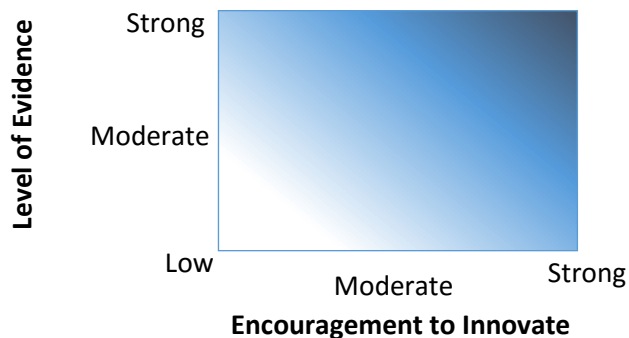
in achieving results in learning) and not merely different. In other words, the public education system does not innovate. But it could. Cautiously.

In establishing protocol for innovation within a continuous improvement regime, an organization must decide how aggressively innovative it chooses to be and, quite importantly, what level of evidence it requires to validate a proposed innovation. In other words, as Table 1 suggests, the organization determines its own sweet spot, the right balance in replacing best practice with better practice. Some organizations will choose to stick close to a continuous improvement process, seeing that its best interests lie in getting the fundamentals right while introducing occasional innovations that have passed muster with strong evidence. Other organizations will put more emphasis on innovation as necessary to their success, more aggressively seeking alternatives to currently accepted best practice and relying on a lower level of evidence to confirm an innovation and move it into implementation.

Table 1: Striking the Balance in Innovation—Finding the Organization’s Sweet Spot

	Encouragement to Innovate		
Level of Evidence	Low	Moderate	Strong
Low			
Moderate			
Strong			

Note to Bob/Stephen: OR graphic something like this?



Periodic feedback, analysis, and adjustment are fundamental to any improvement process. In introducing an innovation, great care is particularly critical in tracking the fidelity of the implementation, the results achieved, and a comparison of productivity with the practice or process the innovation replaced. Redding, Twyman, and Murphy (2013) introduce a key component in the science of innovation—iterative evaluations of the innovation, throughout and after its full implementation.

To identify an innovation in learning, we must define the standard practice as well as the new way and determine that the new way is better. That is a high bar to clear. Validating the comparative advantage of a new practice with gold standard research is a desirable goal but one that lays a cold hand on the experimentation that fosters innovation. However, chasing after the next new thing with little evidence of its efficacy wastes valuable time and money and puts students at risk of missed opportunity to learn. A balance must be struck in highlighting the emerging practices that show promise as true innovation. A proposed innovation can be tested via formative, iterative evaluations prior to the needed validation with randomized, controlled trials (Layng, Stikeleather, & Twyman, 2006). (p. 4)

The Scientific Method.

The process by which innovations are identified and validated is very similar to the scientific method. The scientific method involves the formulation, testing, and modification of hypotheses using systematic observation, measurement, and experimentation. Science Buddies (n.d.) offers a simplified model of the steps in the scientific method:

1. Ask a Question
2. Do Background Research
3. Construct a Hypothesis
4. Test Your Hypothesis by Doing an Experiment
5. Analyze Your Data and Draw a Conclusion
6. Communicate Your Results

These simple steps can be used to support productive change in schools, or more specifically to support innovative practices in the personalization of learning. With a bit of attention and work, SEAs (or districts, schools, and even individual teachers) can apply this process to conceive of an innovation, apply and test it in context, determine the effects, and if effective, move towards scale.

We believe there is much to be gained by more closely approximating best practice in schools through incremental, continuous improvement processes. We also believe applying innovation science to education will contribute to the development and implementation of transformative policies and practices that go beyond striving to meet best practice. Innovation science can help SEAs, districts, and schools catalyze innovation, identify or create tools for change, conduct transition “experiments,” and enable educators to develop competences in innovation.

Applying Innovation Science to Personalized Learning

Personalized learning is a hot topic today, and its advocates contend that it promises to achieve greater results in student learning than more standard instructional practices. The Center on Innovations in Learning (CIL) defines personalization:

Personalization refers to a teacher's relationships with students and their families and the use of multiple instructional modes to scaffold each student's learning and enhance the student's personal competencies [cognitive, metacognitive, motivational, social/emotional]. Personalized learning varies the time, place, and pace of learning for each student, enlists the student in the creation of learning pathways, and utilizes technology to manage and document the learning process and access rich sources of information (Twyman & Redding, 2015, p. 3).

That definition contains a large number of variables, too many in fact, to subject to a single test of effectiveness. From this definition, certain practices might be deduced that would merit examination to determine if they are, in fact, more effective in achieving some aspect of student learning than standard instructional practices. These practices might include:

1. Using appropriate technological tools and programs to enhance student learning.
2. Using data to adapt instruction as needed and as close to instructional moment as possible.
3. Mixing traditional classroom instruction with online delivery of instruction and content, including learning activities outside the school.
4. Granting the student a degree of control over time, place, pace, and/or path.
5. Intentionally addressing students' accessible background knowledge to facilitate new learning.
6. Providing instruction and modeling of metacognitive processes and strategies to enhance student self-management of learning.
7. Promoting a growth mindset, stretching students' interests, connecting learning to student aspirations, and differentiating instruction to enhance students' engagement and persistence with learning.
8. Providing instruction, modeling, classroom norms, and caring attention that promotes students' self-respect, management of emotions, concern for others, and responsibility.

Given that these practices are of a grain-size that makes further specification necessary, itemizing implementation indicators for the practices is useful. For example, let's look at the practice of "Providing instruction and modeling of metacognitive processes and strategies to enhance student self-management of learning." What more specific indicators of the practice might a school team select to test effectiveness using a streamlined version of the scientific method? The following examples of indicators take one element of personalized learning—building students' metacognitive skills—and break it into smaller parts:

1. Teach and model the metacognitive process (goals, strategies, monitoring, and modification) and specific learning strategies and techniques.
2. Include self-checks, peer-checks, and documentation of learning strategies as part of assignment completion.
3. Teach methods of logic, synthesis, evaluation, and divergent thinking.
4. Build students' metacognitive skills by teaching learning strategies and their appropriate application.
5. Build students' metacognitive skills by providing students with processes for determining their own mastery of learning tasks.

6. Build students' ability to use a variety of learning tools.

Enhanced Lesson Design provides a vehicle for studying instructional elements on a small scale, and is also a method for scaling the elements that prove beneficial. Enhanced Lesson Design begins with the premise that the current lesson plan is sufficiently aligned with standard best practice. Rather than creating an alternative lesson, the current lesson plan becomes the basis for the addition of a testable instructional element, such as one of the indicators listed above.

Applying scientific methods to a simple test of the effectiveness of one indicator of one element of the entire definition of personalized learning may appear much ado about little, but, in fact, this is the process of innovation—replacing best practice with better practice, little by little. Managing change in increments of this size is feasible at the school level.

A mini-study to determine how and whether to introduce an element of personalized learning into routine instructional planning would follow these steps:

1. Select a key practice of personalized learning.

Example: Providing instruction and modeling of metacognitive processes and strategies to enhance student self-management of learning.

2. Select a more specific indicator of the practice.

Example: Include self-checks, peer-checks, and documentation of learning strategies as part of assignment completion.

3. Ask a question:

4. Summary of background research:

5. Hypothesis:

6. Insert the lesson element into the current design, modifying the current design as necessary to accommodate difference in time distribution.

7. Test the hypothesis with two groups of students—control (old lesson design) and experimental (new lesson design)

8. Analyze data and draw a conclusion:

9. Communicate your results:

Conclusion

We have described how innovation science can be applied at a small-grain level in a school to advance an element of personalized learning. The whole of personalized learning is a large, ungainly, and minimally tested concept, so it makes sense to introduce it through an iterative process of testing and refining its parts. Personalized learning can be taken to scale—schoolwide, districtwide, or statewide—in this same manner, by first defining the scope and components of personalized learning, then aligning practices, and then setting in motion the experimentation and validation through many small studies. This approach accomplished both an orderly institution of personalized learning and the behaviors that, when routinized, bloom as a culture of innovation.

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